CONSIDERATION OF CANOPY STRUCTURE IN MODELLING C-14 LABELLED GAS BEHAVIOUR IN THE BIOSPHERE FOR HUMAN DOSE ASSESSMENTS

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The global carbon cycle and the long-term implications of continued C-14 discharges from the nuclear fuel cycle have been studied for several decades. Gaseous release of C-14 from the geosphere to the biosphere is primarily of interest in the context of disposal of low and intermediate level radioactive wastes containing substantial quantities of degradable organic materials. This can give rise to releases of carbon dioxide and methane labelled with C-14. In addition, in anaerobic conditions, bulk hydrogen can arise from metal corrosion and can act as a carrier gas. With inorganic wastes, e.g. HLW and spent fuel, bulk carbon dioxide gas production may be of much less significance. When assessing the potential impact of gaseous release of C-14 labelled gas from the repository to the biosphere much can be learnt by considering the impacts of atmospheric releases of C-14 labelled gas, e.g. from a nuclear power plant. For example, the impacts of atmospheric releases of C-14 labelled carbon dioxide upon potatoes and rice where considered by the IAEA EMRAS tritium/C-14 working group. In a waste disposal context, the international BIOPROTA forum (www.bioprota.org) has an established C-14 working group, which has carried out a qualitative model review and two quantitative model inter-comparisons of soil-plant-atmosphere systems. The following organisations are currently supporting the BIOPROTA C-14 working group: Andra, CIEMAT, EDF, the UK Food Standards Agency (FSA), IRSN, LLW Repository Limited, Nagra, NDA RWMD, NUMO, Posiva, SKB, SSM, the University of Nottingham and the University of Eastern Finland. The BIOPROTA quantitative model inter-comparison studies have demonstrated the sensitivity of model results upon the conceptualisation of the aboveground atmosphere, specifically the representation of vertical and horizontal air exchange within the area of interest and any loses from that area. The LLW Repository Limited has recognised the potential importance of the processes being considered in the BIOPROTA working group and developed a new C-14 model that addresses the exchange of gas in a soil-plant-atmosphere system. In particular, this model considers two regions in the aboveground atmosphere and utilises concepts from the field of micrometeorology to describe the exchange of air between these regions and losses from the area of interest. The lower layer only experiences molecular diffusion processes in relation to the movement of molecules of carbon dioxide, whereas the upper layer experiences some degree of turbulent mixing as a result of winds which flow over the area of interest. The thickness of these layers, and the degree of plant uptake of carbon from these layers, is dependent upon the canopy density, which will affect the light intensity and thus the rate of photosynthetic uptake of carbon in the canopy

profile. Model results demonstrate the impacts of gaseous C-14 release from the soil upon the calculated C-14 concentration in plants for a variety of plant species (grass, root and leafy green vegetables, and garden fruit) and subsequent doses to human exposure groups. The technical modelling work described has been funded by the LLW Repository Ltd in support of the development of its Environmental Safety Case.